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THE PLACE OF MENTAL IMAGERY AND MEMORY AMONG MENTAL FUNCTIONS.

By FRED KUHLMANN, PH. D., Assistant in Psychology,
Clark University.

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The ability to learn has been made a criterion for the existence of consciousness. And in these instances the term 'learning' is used in the individual sense but may include hereditary maturation of functions during the life of the individual, as well as the functions that are learned in the narrower sense. The methods of the acquisition of function are various, and not all of them belong to the individual. It may be profitable to mention at least what from the present point of view may be called the racial method of learning. Whether the evolution of animal organisms takes place through natural selection and this alone, or by other means as well, the fact that an evolution has and is taking place with most animal species will perhaps not be denied. In the experience of a species with nature and with itself, like that of the individual in his limited environment, it is making progress in the ability to deal with that environment and nature. It is making adaptations. And this may, in the wide sense, be called learning. It has indeed by some been designated by the term 'organic memory.' As far as dealing with the problems of life is concerned the result of this sort of learning is for the individual not different from any other sort. The individual of each successive generation, in a very general way, finds himself better able to cope with the difficulties that nature presents to life than the individual of the preceding generation. And this is the function of individual

acquisitions. It is an improved ability to do and to live. But, excluding the inheritance of acquired characters the individual has in this case had no hand in this progress. Nature has produced the variations, and has done the selecting of the best by killing the others. Or, if we choose to regard the variations as produced by the individual, the latter has had no part in their production through any influence of consciousness or through the influence of those of his activities that need a schooling for their perfection. Consciousness is not a necessary factor in this mode of progress, nor is functional activity. It is strictly within the realm of hereditary improvement. In the more complex and highly organized nervous system of man the human race shows the results of a schooling from nature far in advance of any that has been received by any of its competitors. It has learned to react to its environment in ways that make it get much more out of nature, make a much more extensive use of it than lies within the possibilities of any other species. The greater flexibility of the human nervous system, its greater capacity for individual acquisitions, or learning in the narrower sense, is one of these marks of superior training in Nature's school. But in the prominence of this fact, the greater educability of man, we are apt to lose sight of his other superior hereditary endowments which are equally the result of a natural evolution. And when we contemplate the scope and significance of what a man can learn in a lifetime, and the individual differences in this respect where the natural endowments have been more or less equal, we are still more apt to forget the rôle that the latter are playing. Nature's methods in producing these results have been slow, and the ages of history required in making man make it seem like the employment of a clumsy procedure, against which the results of the individual's education appear in a false light, and a light which is borrowed at that. In the further consideration of this general topic this fact should be constantly borne in mind. For unless this is done we lose sight of the real relations between the various factors that enter into making the human mind superior in adaptability and in the ability to learn.

We may turn now to the methods of learning, when the term is used in the individual sense. How can the individual make acquisitions that are useful in life? As was stated a few moments ago, the ability to learn has been made the criterion for consciousness. 'If the individual cannot learn to react more profitably to stimuli as the result of his experience we have no evidence for the existence of a conscious life. And *vice versa*, without consciousness the individual cannot thus profit by his experience.' Before accepting this assumption we should at least raise the question of the possibility of the individual's

ability to learn where consciousness does not enter as a factor. A purely neurological adaptation of a reaction to a stimulus is at least conceivable; and why should not the same be possible, also, even where there is no nervous system? A physiological, or, ultimately, mechanical explanation alone could be made of such a phenomenon. But why should not such a mechanical process be possible and sufficient to produce the results in question? Such a process we conceive to be associated with the activity of neural tissue concerned in conscious life. What is there, in our theory, about this physical process that may not be also present in every living cell? This is a theoretical question and no answer can come from observed fact, but must be derived, if obtained at all, from inference. We can determine the ability to learn in animals, but we cannot tell, directly, what kind of a life this implies.

But there is another aspect in the assumption that consciousness and the ability to learn go together and that the latter may be made a criterion for the former, in which our answer need not be entirely speculative. It is implied that in learning from experience a *conscious* use is made of that experience. 'There is some sort of conscious memory of the experience and it is through this that the adjustment in the reaction to a stimulus is made. It is an intelligent reaction or behavior, as distinguished from the instinctive, the reflex, and the habitual.' The view that this must necessarily be so is, however, hardly tenable. There are types of learning in the human organism that do not consist of a conscious adjustment of the reaction. These may be for the most part instances in which the hereditary maturation of structure is involved, but in any case perfect functional activity is preceded by a period of imperfect functioning without which the later perfection is not acquired. Hereditary structural growth alone is not sufficient, but it requires the stimulus and activity for functional development. In this sense, there is probably an education of all of the involuntary muscles of the body. The sympathetic nervous system has a variety of functions to perform, and the detail of its duties must undergo many changes during the period of growth from birth to the adult life. On the functional side we know very little at present of just what adjustments must be made in the activities of the different organs of the body. On the structural side, we know that most of the viscera, glands, and other organs show no regular course of development. This is reason for believing that the functional adjustments also are greater and more varied than have been yet determined. The first radical change comes at birth. A digestive system, with quite a series of associated glands and organs, must now learn to do its work. It is a learning process

in every sense of the word excepting that a conscious guidance of the activities involved is absent. The digestive, assimilative, and secretory processes of the infant are quite a different matter from those of the adult. The salivary glands are at birth practically inactive. The movements and the secretions of the stomach and the intestines change. The same is equally true of the functions of the liver and spleen, and of the kidneys. A second radical change at birth takes place in the circulation. With the cutting off of the placental circulation the blood takes, in part, a different course, and an adjustment in the circulatory mechanism is required. Structurally and functionally the heart and arterial system undergo many variations from birth to maturity. Breathing with the infant has some well marked characteristics at birth, and comes within the course of a few weeks to take on a more or less permanent character. But the function is not perfect at first. The lungs do not entirely expand, and may not do so until the end of the second week. The breathing is irregular. One lung may be at times inactive. The breathing has not its later normal rhythm, except during sleep. A period of tuition is required in order to attain the ability to do its perfect work.¹ Instances of this sort might be multiplied, but this is perhaps not necessary for our present purpose, which is only to call attention to the fact that there are many cases in which the various functions of the sympathetic nervous system and the involuntary muscles require considerable readjustment in order to meet the complex demands of a growing organism. Many of the cases that might be cited under this class require perhaps no more than a purely mechanical readjustment; mechanical in the sense that no period of more or less gradual functional development precedes the perfect form. But many other cases clearly do require such a preliminary schooling.

Better known examples, however, of functional development where conscious guidance is not involved are found in some of the early reflexes of semi-voluntary, and voluntary muscles. Here, too, it will not be necessary to state details. A large group of these reflexes is connected with the muscles of the face and its sense organs. The natural reaction in the facial muscles, especially to tastes and odors, pleasure and pain, is quite uniform in the adult and in early childhood. But they are not present at birth, and most of them show a distinct though brief course of development. Thus there are the perfectly reflex facial expressions in response to bitter, sour, sweet; to pleasant and unpleasant odors, to pleasantness and

¹Oppenheim: *The Medical Diseases of Childhood*, N. Y., 1900.
Holt: *Diseases of Childhood*, Phila., 1899.

unpleasantness in general, which the child *learns* to make. More definite still than these are the reflexes of some of the eye muscles. The muscles that move the eyes have to learn to act together in the delicate harmony of movement required of them in binocular vision. The ciliary muscles of accommodation must learn to adjust the lens for near and far vision. The iridian muscles must regulate the size of the pupil in response to increase and decrease in intensity of light, and to changes in accommodation. All three sets of ocular muscles must learn to act together in the complex act of vision, a thing of which they fall far short at birth. The wink reflex of the eyelid, also belongs to this group. These instances of the development of reflexes are cases that perhaps no one will question with reference to the absence of a conscious guidance of the activity. Whatever sensations arise from the stimuli and from the contraction of muscles and the movements of the sense organ, and whatever the influence of these sensations may be in the adjustment of the reaction, we cannot believe that the child at this age makes voluntary use of these sensations in a voluntary guiding of these fine and quite complex co-ordinations. There are also many other co-ordinations that are of the reflex order, and are made during early childhood, that may not so clearly belong to the above type, but which yet on the whole resemble them closely. These are the various early co-ordinations of the voluntary muscles. Here belong first those involved in the development of space perception, *e. g.*, the reflex turning of the head in the proper direction when a sound is heard; the reaching out towards objects when seen within reaching distance; and the very numerous co-ordinations between stimulation of the skin and arm and hand movements, by means of which stimuli on the different parts of the body are localized and the child comes to what we are accustomed to call an 'acquaintance with self.' Still further removed from the first group in their less reflex character and in the degree in which voluntary control plays a part in their acquisition are the later co-ordinations among voluntary muscles, such as learning to walk, and learning the co-ordinated use of arms, hands, and fingers, together with the other muscles of the body, as they come into play in the ordinary activities of daily life. These co-ordinations are practically all acquired during early childhood and they all approach the character of the reflex, at least so far as the interconnection of the movements of the separate groups of muscles is concerned. The will plays a part only in initiating or inhibiting the series. Consciousness plays a part in their acquisition in repeatedly initiating the effort to perform them as wholes, but we could hardly go further and say that the child is aware of the separate movements involved in such com-

plex acts, conceives of them beforehand and consciously guides them in their required succession.

In the learning of these activities we are touching upon a method of learning that is not peculiar to early childhood, but is shared by all adults in this sort of activity. Before passing on to the next topic we may pause, therefore, for a moment, to consider what sort of memory is involved in this kind of learning. It is the kind of learning of which we say that we learn by doing, and not by reasoning it out. We are conscious of some of the factors in the total complex ; we are conscious of the purpose of the whole, of the effort we put into it, of a very general and vague sort of voluntary directing of our movements and mental processes; we have perhaps sensations resulting from the movements, and we are aware of the accuracy or inaccuracy of our results, of our success or lack of success in what we are trying to do. But on the whole the progress in our skill does not come about *mainly* through conscious guidance, through conscious correction of previous errors. We acquire skill in writing, in gymnastic exercises, in swimming, skating, rowing, in learning various games, by *practice*, by repeated, more or less blind efforts, in which we very seldom recall a previous error, which we then consciously avoid, or by foresight of the correct procedure carry out our conceptions of it with attention to the details in the activity. The progress that we make in our ability comes about through a *neural* adaptation, in which the organism is not burdened with the higher processes of memory and intelligent action. The adaptations take place unconsciously; we become aware of them only after they are made, and have little to do with their making. To be sure we need our sense organs in these activities, and the deduction might be made that memory images of previous activities, must enter into the learning process. But as a matter of fact, they rarely, and in some instances never, do. The memory involved in this sort of learning is not conscious memory. It is neural only. It is learning in a conscious individual and consciousness takes a distinct part in the activity in which progress in ability is being made, but the learning does not take place mainly through conscious guidance of corrected movements, etc. It is a method of learning distinct from those described before and from the method to be considered next. There will be occasion in other connections to recur to it again for further consideration.

We come now to consider the memory image and the mental image as factors in the ability to learn. The existence of the type of learning just described demonstrates the possibility of progress in the ability to do certain things without the guidance of conscious memory, or of mental imagery. This fact, how-

ever, has never been taken into consideration in the efforts to determine what sort of mind was implied in the ability to learn in the case of lower animals. The ability to learn has by some not only been set up as a criterion for consciousness, but also as a criterion for the memory image. In the next few pages I shall attempt to state briefly the discussion that has arisen on this point.

Much of our older and even present day psychology holds that perception and the memory image mutually imply each other. 'Perception is a very complex process in which the memory of much previous experience is included. It is really a sensation simultaneously supplemented with mental imagery of the past.' According to this view the question as to the priority of consciousness and the memory image, or the necessary implication of the latter in the former, is settled. Perception implies the memory image and hence there can be no consciousness at all without the presence of the memory image. Possibly this view has influenced some of those who have accepted the ability to learn as a criterion for consciousness. Loeb makes this criterion 'associative memory,' which he defines as 'the ability to learn or the ability to profit by experience.'¹ If there is associative memory there is consciousness. He is not very explicit as to what is to be included in associative memory. The definition just stated, which he usually uses, does not define it with reference to the kind of memory meant. From some other statements, however, it becomes quite clear that he uses the term in the more usual sense. He means by it mental images that result from past experiences. Whether these mental images are complete memory images, that is, have included in them the recognitive elements that make the subject aware that his imagery relates to his own personal past experience, which he localizes with reference to time and place, cannot be made out with certainty from his descriptions. A few quotations will give his point of view, so far as he states it explicitly. "By associative memory," he says, "I mean that mechanism by which a stimulus brings about not only the effects which its nature and the specific structure of the irritable organ call for, but by which it brings about also the effects of other stimuli which formerly acted upon the organism almost or quite simultaneously with the stimuli in question. If an animal can be trained, if it can learn, it possesses associative memory."² In another place he says: "We may conclude that associative memory is present when an animal responds upon hearing its name called, or

¹ *Physiology of the Brain*, N. Y., 1900, pp. 12, 214, 218.

² *Ibid.*, p. 12.

when it can be trained upon hearing a certain sound to go to the place where it is usually fed. The optical stimulus of the place where the food is to be found and the sensations of hunger and satiety are not qualitatively the same, but they occur simultaneously in the animal. The fusion or growing together of heterogeneous, but by chance simultaneous, processes is a sure criterion for the existence of associative memory.¹¹ Again: "The odor of a rose will at the same time reproduce its visual image in our memory, or, even more than that, it will reproduce the recollection of scenes or persons who were present when the same odor made its first strong impression on us. By associative memory we mean, therefore, that mechanism by means of which a stimulus produces not only the effects which correspond to its nature and the specific structure of the stimulated organ, but which produces, in addition, such effects of other causes as at some former time may have attacked the organism almost or quite simultaneously with the given stimulus."¹² In the last quotation he defines what he means in the first by the 'effect of a stimulus' which is reproduced not by its own stimulus that first produced it, but by another that was once associated with the former and is now present. He means, apparently, the memory image of the previous stimulus. Thus, implicitly at least, he holds that the ability to learn involves the function of the memory image.

Lloyd Morgan is in essential agreement with Loeb, although he points out some distinctions not considered by Loeb. He accepts the ability to 'profit by experience' as a criterion for the existence of consciousness in animals.⁸ But for him there may be two grades of consciousness that are fundamentally different with reference to their survival value. Organic behavior may be accompanied by a mere *sentience* only, a conscious accompaniment that does not influence or guide behavior. Or it may be accompanied by *effective* consciousness, a consciousness that does guide behavior. The ability to profit by experience is a criterion only for effective consciousness. He raises the question as to the kind of memory involved in this, and rules out conscious memory, that is, the complete memory act, from playing a part in animal behavior. There is, first, no localization in time. The animal does not remember his experience as belonging to a definite part of his past with reference to time.⁴ Such a memory would have little or no practical value for animals, and there is no basis for assuming its presence. There is only a re-instatement, a re-presentation of the past experience in terms

¹*Ibid.*, p. 218.

²*Ibid.*, p. 214.

³*Animal Behaviour*, Lond., 1900, p. 42.

⁴*Introduction to Comparative Psychology*, Lond., 1900, p. 122.

of mental images and their previously associated affective processes. In the chick's second experience with the caterpillar "the *presentative* visual stimulus now calls up *re-presentative* elements, motor and gustatory; and these place the situation in a wholly new aspect. They give it what Dr. Stout terms 'meaning.'"¹ In another statement he refers more definitely to the distinction in point. "We may now substitute for the word remembrance," he says, "the more technical term representation. Profiting by experience, regarded as a criterion of the presence of effective consciousness, involves re-presentative elements in the conscious situation which carry with them meaning."² In a word, then, he assumes the mental image as a necessary factor in the ability to learn. If his terms 're-instatement,' 're-presentation' are to be taken literally, he excludes the recognitive elements involved in the full memory act. These are unnecessary factors for 'intelligent' behavior. In this he differs, apparently, from Loeb. Incidentally, too, attention may be called to the fact, that his effective consciousness implies that it guides consciously. It makes use of mental images and by means of them guides action. Learning for him can take place only through conscious guidance.

In a discussion on "The Genesis and Function of the Memory Image" Bentley takes a quite different view in regard to the relation of the image to the ability to learn. The mental image, which Loeb and Lloyd Morgan regard as the essential factor for the possibility of learning, Bentley considers unnecessary. And the recognitive elements in memory which Lloyd Morgan excludes as unnecessary, he regards as the only factor needed for the adjustment of behavior in accordance with experience.³ They differ then as to what elements in the complete memory act are involved in learning. His view seems to be based upon one established fact concerning *human* consciousness, although he does not explicitly point out this relation. This established fact is that recognition of an object can, and sometimes does, take place without the presence of a memory image of that object as previously experienced. We are immediately aware of the object, in these cases, as a familiar one without our recalling that we have experienced it before. According to him the consciousness that is capable of mental images is a stage in advance of a simpler type in which mental images do not occur. The organism possessing the latter form, to be sure, has a memory, and is capable of profiting by experience. But it lives, and can live only in the immediate present.

¹ *Animal Behaviour*, p. 46.

² *Ibid.*, p. 47. Also *Introduction*, p. 122.

³ *The Memory Image and its Qualitative Fidelity*. *Am. Jour. of Psy.*, 1899. pp. 18-23.

Its consciousness is all of the perceptual kind, and without the presence of a stimulus there is none. Perception and recognition are sufficient to do the simple business of its life, and the recognition is of the immediate sort. The mind that can *imagine* is of a higher grade, and learning with the use of mental images is quite a different method of progress. The perceptual consciousness involves the past experience of the individual. There is memory in this sense only. But as perception is psychologically simpler than recognition, so recognition is a simpler process than a memory that involves mental images. Since recognition is possible without mental images, and since no more than this is needed to account for the ability to profit by experience, the point at which the mental image comes in in the biological development of consciousness becomes a problem to be determined. A few quotations will make his view clear on this point. "So long," he says, "as a rough-and-ready attitude towards the world suffices for survival, images will not appear. It will only be after the non-present has been thrown up against the background of perception that its content will be conceived as possibility and then a warning,—and thence the way to prophetic adaptation (adaptation by the use of mental images) will be short."¹ "Thus cognition or simple recognition would govern reaction towards the immediate environment, and only a later and more complex stage would demand conscious previsory adaptation (adaptation through mental images). This stage would be the longer delayed because instinctive reactions are reinforced among some of the higher animals by a motor habit, set up through the individual's experience, which seems to mediate recognition without the addition of memory images."² "If we take the biological point of view, it seems altogether probable that the memory image was a comparatively late acquirement for the organism. A command of consciousness through active attention, that should abstract from the pressure of the immediate environment and hold an isolated sensation-complex, aroused by central excitation, is the prerequisite of the image. A highly complex nervous apparatus seems necessarily involved."³

Bentley does not attempt to describe further what kind of a mind it is that makes its adaptations without the use of mental images, but he considers what rôle the mental image plays when it does appear in mental evolution. This I shall take up in a moment. Thorndike approaches the same problem from the results of experimental studies on animals. He is in entire agreement with Bentley with reference to the ability to learn without the use of mental images. He also makes some further

¹ *Ibid.*, p. 23.

² *Ibid.*, p. 22.

³ *Ibid.*, p. 18.

efforts to describe this sort of mind.¹ He classifies the methods of learning into three types: (1) Learning by trial and accidental success. (2) Learning by imitation. (3) Learning by ideas, where the situation calls up some idea which then arouses the act or in some way modifies it."² The first method is that of animals, or more correctly, of the animals he has studied. It does not involve the use of 'free ideas,' which term he uses instead of 'mental image.' The adaptation in the reaction to a stimulus is here brought about first by accidental success, and then a subsequent strengthening of the associative connections between the present sense impression and the correct reaction. The many reactions that are wrong at first are not so strongly associated with the corresponding sense impressions. The right reaction is followed by the satisfaction of a desire, emotional elements that give an advantage to the associative connection between this reaction and the sense impression. This connection is direct; the reaction is immediate. There are no re-presentations of past sense impressions and the past reactions with its results between the now present sense impression and the now correct reaction. Thorndike does not further compare this process of learning with the factors involved in memory, and recognition of the human mind, and it is not quite clear as to what he would include in it from this point of view. Taken as stated, this kind of learning is a simpler process than even Bentley's view implies. The animal does not react from the *recognition* of a situation that has come to be familiar to him through previous experience, but he comes to do so directly, without his knowing, or feeling why. The difference between the first and the later correct reactions is perhaps only that he finally comes to react more readily, has a stronger impulse to react in this direction immediately upon the presentation of the stimulus and the sense impression. From the animal's point of view, he simply comes to do it right, and that is all.

To make clear and more definite the differences in all these views as to what is involved in the ability to learn, we may take Lloyd Morgan's illustration of the chick learning to eat the 'good' and not the 'bad' caterpillars. The facts here are that the chick at first pecks indiscriminately at caterpillars that it does not like as well as those it does like, but comes finally to peck only at the latter. Loeb would seem to hold that after a little experience the sight of a particular caterpillar would produce a memory image of previous experience with this sort

¹Animal Intelligence. An Experimental Study of the Associative Processes in Animals. Psyc. Rev. Mon. Supl., 1898. The Mental Life of the Monkeys, Psyc. Rev. Mon. Supl., 1901.

²Mental Life of the Monkeys, p. 2.

of looking thing, a memory image of another caterpillar like this and of how it tasted. Upon the basis of this the reaction is adjusted. If the memory is of a bad taste the caterpillar is left alone, etc. Lloyd Morgan would not attribute to the chick a complete memory image; no conscious memory. Upon the second sight of a particular caterpillar there is a representation of the previous experience, visual and gustatory. This is sufficient to adjust the reaction. But the chick is not aware that it has seen or tasted this sort of thing before. According to Bentley's view there is no re-presentation of past experience, visual or gustatory, at the second sight of the caterpillar, but there is a direct recognition of it as good or bad, as something to be eaten, or something to be avoided. It is a familiar thing that means to the chick, 'eat' or 'don't eat.' From this the proper re-action follows, as in Lloyd Morgan's case. Finally, Thorndike does not include even such recognition. The chick at first eats good and bad alike, with the results of satisfaction or dissatisfaction. From this experience the associative connections between the visual stimulus and the movements in eating become strengthened in the one case, weakened in the other. No mental images or cognitive processes are necessary for this strengthening or weakening of associative connections. The 'good' or the 'bad' caterpillar does not come to *mean* anything different to the chick than it did before. He simply comes to eat with a stronger impulse to do so in the one case, and with a weakened impulse to do so in the other. Thorndike attempts to describe the animal consciousness, and the animal's method of learning in general terms, and points out what seems similar to this in the human mind. This description I shall quote in full. "One who has seen the phenomena so far described," he says, "who has watched the life of a cat or dog for a month or more under test conditions, gets, or fancies he gets, a fairly definite idea of what the intellectual life of a cat or dog feels like. It is most like what we feel when consciousness contains little thought about anything, when we feel the sense-impressions in their first intention, so to speak, when we feel our own body, and the impulses we give to it. Sometimes one gets this animal consciousness while in swimming, for example. One feels the water, the sky, the birds above, but with no thoughts *about* them or memories of how they looked at other times, or aesthetic judgments about their beauty; one feels no *ideas* about what movements he will make, but feels himself make them, feels his body throughout. Self-consciousness dies away. Social consciousness dies away. The meanings, and values, and connection of things die away. One feels sense-impressions, has impulses, feels the movements he makes; that is all. This pictorial description may be sup-

plemented by an account of some associations in human life which are learned in the same way as are animal associations; associations, therefore, where the process of formation is possibly homologous with that in animals. When a man learns to swim, to play tennis or billiards, or to juggle, the process is something like what happens when the cat learns to pull the string to get out of the box, provided, of course, we remove, in the man's case, all the accompanying mentality which is not directly concerned in learning the feat. Like the latter, the former contains desire, sense-impression, impulse, act and possible representations. Like it, the former is learned gradually. Moreover, the associations concerned cannot be formed by imitation. One does not know how to dive just by seeing another man dive. You cannot form them by being put through them. One makes use of no feelings of a common element, no perceptions of similarity. The tennis player does not feel, 'this ball coming at this angle and with this speed is similar in angle, though not in speed, to that other ball of an hour ago, therefore I will hit it in a similar way.' He simply feels an impulse from the sense-impression. Finally, the elements of the associations are not isolated. No tennis player's stream of thought is filled with free-floating representations of any of the tens of thousands of sense impressions or movements he has seen and made on the tennis court. Yet there is consciousness enough at the time, keen consciousness of the sense-impressions, impulses, feelings of one's bodily acts. So with animals. There is consciousness enough, but of this kind."¹

In this passage there is pointed out a way in which the animal and the human method of learning, as far as the learning process itself is concerned, are essentially alike. In each case conscious memory, conscious guidance of action does not take place. What then is the function of the memory image where it does exist? The answer may now be brief. Without it consciousness must move within the narrow limits of the present. No memory of the past, and no expectation for the future can be there. Although adaptations can and do take place, as we have seen, they must all be made at the spur of the moment, in the immediate presence of the stimulus that has once caused a wrong reaction, and calls for a readjustment on the part of the organism. With the memory image, consciousness transcends the present, and recalls not only the past but penetrates the future as well. Indeed, the backward look of the memory image is its least contribution to life. This may add to its æsthetic enjoyment, but it is the forward look that carries with it the utilitarian significance. By means of it the

¹ Animal Intelligence, pp. 83-84.

organism may now look ahead, may decide upon and adjust its reaction beforehand, in the expectation of meeting the same situation again. To quote Bentley once more: "The primary use of the image, we surmise was to carry the organism beyond the limits of the immediate environment and to assist it in fore-seeing and providing for the 'future.' Its function seems, then, to have been a prophetic one; it was a means to what we may term *remote adaptation*. . . . When once the capacity for independent imagery has been acquired, the stress of existence will inform the image with significance. The significance will, undoubtedly, be vague for a time. The image will mean a situation which does not belong to the one immediately presented; its temporal situation will still be unfixed. Later, its extreme importance will attract the attention, and thus it will be reacted upon. As an element in action, it will become more and more teleological; it will become the headlight of consciousness, pointing before to an experience which is to follow, and which must be provided against."¹

We have come now to the point in the biological evolution of consciousness where the mental image and memory become of conscious use. The individual has now a conscious record of his past. He can consciously recall his experience, can think about it, can see the errors in his behavior and can decide upon the proper mode of reaction to a situation that he has once met and expects to meet again. The memory image has truly furnished a means to remote adaptation. It has supplied the conditions for a method of learning that far exceeds any of the others so far considered. At this point we may raise the question whether the memory image has retained this supreme function in the further development of consciousness as existing in man, or if not, what place it now holds as a means of guiding human conduct. Have any other methods of adaptation been reached that exceed even the memory image?

In the consideration of these matters we come at once when we turn our attention to human life to some fundamental distinctions. The human individual of the present, at least, is capable of making use not only of the memory of his own experience but of the history of the whole race that has preceded him. Several new factors have come in to make this possible, and to change further the means and methods of guiding conduct. These factors are closely related to each other, but I shall attempt to state them separately under (1) the influence of language; (2) the limitations of our immediate sensory data; (3) the rôle of reason and science in life.

Perhaps no other one factor that belongs quite entirely to the

¹*Ibid.*, pp. 18-19.

history of the *human race* has influenced mental imagery and memory as much as has language. Without the existence of language, spoken or written, no adaptation through the combined knowledge of the race was possible. Outside of what could be learned through imitation and other non-linguistic forms of suggestion the only source of information that the individual could make use of in consciously guiding his conduct was that of the memory of his own experience. And that experience could be held together only in terms of memory imagery, however abstract and remote from the original sensory data this might become. Memory of the individual's own experience stood supreme as a means to adaptation and of guiding conduct. With the introduction of language, especially written language, the conditions for radical changes were given. With respect to his own experience the individual can now cast this in terms of a system of symbols that are at any time convertible into the memory of the original, and which are vastly easier to preserve than the original memory images. The written record can be made to tell the story of his life, his individual acquisitions, all that he has learned that will aid in meeting the difficulties and the problems of life. The details of the contents of this record he need not constantly keep in mind. Indeed, life is so very complex and so very rich that memory finds itself altogether inefficient in preserving the great store of practical information that a record of its experience could teach. The individual cannot and need not remember its content; he needs only to remember the existence of its linguistic record and where to find it. This latter memory becomes one great symbol for information that it has taken a lifetime to collect, and this symbol is a substitute for, and serves the purpose of, the original memory of it all. But this is the least of the functions that language can and has performed in furnishing a means for guiding the individual's conduct. With it the individual transcends the narrow limits of his own past, and his own consciousness. The past of the race, so far as recorded in language, becomes the common heritage of every individual. Compared with this vast store of practical information that the race has contributed for the use of future generations that of the individual stands as of little or no consequence. Language has made this accessible. The significance of the memory image in its old form as an immediate means to adaptation has dwindled almost to zero.

In giving to language this function we have included already the results of other factors that were mentioned for consideration. The experience of the race is more than the collective *immediate* experience of many individuals. But for the moment let me regard that experience as strictly and purely em-

pirical. It is the recorded gross observation of man, left in its first form without being reduced to general rules and laws of nature. It is data for science, but not science. It is memory data cast into a linguistic record, not the result of a rational treatment. Viewed from this standpoint the insufficiency of memory as a means to adaptation and for guiding conduct, as compared with science, becomes at once quite apparent. That insufficiency is the result of the short comings of our sensory data. Our memory alone cannot transcend the material furnished by the senses. And nature has given us a set of senses which (although taken together, they are the best in the animal series), are yet a poor makeshift as a direct means to a perfect adaptation. Among the innumerable forces in nature and the forms in which they express themselves there are very few indeed that it is given to us to know directly through our sensory equipment. A small scale of sounds we can hear in a range of vibration frequencies in nature that we have not even the means to imagine. A certain intensity we can sense, but below the threshold lies a world of sounds for which we can only infer an existence. At other points in the scale we pick out small groups of vibrations that we sense as heat or light, but the vast creation of forms of forces in matter and ether we may long to know, and we may think about, but we cannot know directly. Small distances and large objects we can see, but we add telescopes and microscopes to our eyes and with them we wonder at the mysteries of structural nature that we cannot puzzle out. Yet that knowledge, which lies beyond the immediate reach of our senses, we must have, for it has the highest sort of survival value. We must know nature fully. This knowledge, which we might have, had we the proper sense organs to obtain it, we are slowly acquiring in another way. We are obtaining it through a laborious task of inference and reasoning, the results of which as expressed in the sciences mark progress towards better means to better adaptation. The method of adaptation is here far removed from that which consists only of direct sensory data and memory of that data or the linguistic record of that memory. And to the extent that this is the case the memory image in its old form, however recorded, has lost most of its significance, its survival value. In language is recorded not only the empirical experience of the race, but also the history of its sciences. Against this background of knowledge that of the individual is lost sight of almost entirely. In fact, few individuals attain the mental scope to make a practical use of more than a very small portion of the race's contribution to science.

But science has another use than has so far been implied.

We have considered science as a means to adaptation and for guiding conduct only in so far as it supplements the insufficient sensory data. The memory of our immediate experience can never get beyond what the senses furnish, and if this is inadequate, memory must be at least to the same extent inadequate. Science has extended sensory knowledge. But this extension merely by added observations is science's smallest function. The memory image of the individual's immediate experience has been called the means to a remote adaptation, because upon the basis of it the individual could adjust his reaction beforehand in the expectation of meeting the same situation again. But science has supplied a means to remote adaptation in a far larger sense than this. The empirical observations are reduced to general rules and laws of nature. In some places at least we know nature to such an extent that we know what she will do before she does it. We need not wait for that experience; we can tell what it will be beforehand and can adjust our procedure accordingly. The experience that may injure or cost the life of the individual before he can know how to adjust his behavior can be avoided through the knowledge that science affords. Science looks to the future far beyond the limits of the individual's memory of his own experience. It looks into the past also far beyond the reach of either the individual's or the race's memory.

In this consideration of the larger relations between memory and reason in science we have lost sight for the moment of what rôle they play in the everyday life of the individual when he is neither attempting to be scientific nor particularly conscious of guiding his conduct according to the dictates of the memory of his previous experience. Life is wider than merely its utilitarian aspects; and conduct consists of more than adaptation of reaction with reference to survival. In the fuller and richer scope of consciousness, what places do memory and reason hold? The main fact in answer to this question may be stated here at once. In the vast majority of instances man's actions are a matter of habit, in which neither reason nor conscious memory enter, or follow from accepted authority, in which case reason and conscious memory are equally absent. Man is regarded as the only rational being, but it is only in very rare moments that he is consciously rational. It has taken nature a long time to produce this supreme function in the animal organism, and it requires the results of the last stage in the development of structural complexity. It is too precious a function to be employed in the usual and ordinary activities of life. The guidance of these is handed over to other methods.

If to this extent we must depreciate the function of reason in everyday life, we must to an equal, if not greater extent, de-

preciate the function of mere memory. It has been said that the function of forgetting is as important as is that of remembering. This touches one aspect of a fact to which we may turn our attention for a moment. It is not so much in how much we remember, but in how we select in our remembering that the mind becomes efficient and makes progress. If we remembered with equal tenacity all the experiences of our life, that condition would be as fatal as that of the absolute absence of memory. Attention was called before to the insufficiency of our sensory data as a direct means to adaptation. In the contemplation of this fact we should not forget that our salvation lies in part in forgetting practically all of the limitless mass of data that is constantly being presented to consciousness. Of the many thousands of impressions that reach most of our sense organs every hour, it is only the very exceptional one that is remembered the next hour; it is only the very exceptional one that rises above the threshold of consciousness sufficiently to become the object of attention even for an instant. Of the many incidents that we attend to during a day, of the thoughts we think, and the emotions we experience, it is a very rare one that we honor with a second thought. If we ask why this should be so, the answer is at once that these things have no interest, no significance, no value. It is, indeed, one of the marks of superiority that the mind *can* disregard them. Attention to them would mean so much energy wasted, so much distraction from the more serious and important affairs of life, a break in the continuity of a consistent purpose that runs, or ought to run, through all our conscious living. But what is significant in this for our present consideration is the fact that mere memory takes here a subordinate place. It is not the indiscriminate retention and recall of all our experiences but the proper selection of data for memory that is significant; a factor of superior importance comes in that makes the proper use of the memory faculty, and it is through this proper use alone that memory becomes of value to life. What this more important factor is is difficult to describe. We cannot say that we, as a rule, make a rational selection of what is to be remembered and what is to be disregarded. In the majority of instances we certainly do not reason it out. It is rather the whole life of the individual that enters to decide.¹

This view depreciates mere memory as the factor that determines what is to become a more or less permanent part of our mental life and what in our experience is to be excluded.

¹ This aspect of the matter and those that I touch upon below have been luminously treated by Stratton: *Experimental Psychology and Culture*, N. Y., 1903, pp. 187-195.

There is one other matter to be noted in which memory alone does not play so great a rôle as might seem, or as is usually supposed. With those experiences that we do wish to retain and attempt to recall the naïve assumption is that, after the original experiences are once past, it is memory alone that decides what and how we shall recall them. But the phenomena of memory illusion and our own introspection shows that this is not so. In the attentive recall of our experiences we read into our memories things that we do not really possess as memories; we remember things as we think they ought to have been. In this our knowledge of the order of nature, or other logical motive, takes the place of memory, and reconstructs our experience where memory finds itself deficient. Through a long schooling with nature we have acquired an insight into her ways, and when we are called upon to say how such and such an event took place it is this insight as much or more than it is memory that is determinative for us. We have many memory illusions, but we never remember a thing as having occurred contrary to what we think is a law of nature. "After all," says Stratton, "and especially when we try to interrelate events lying in the more distant past, our main dependence is upon our knowledge of how things *ought* to go together, rather than upon simple sensations or emotions or upon the elements of distinctness. We learn some of the more elementary laws of nature and, guided by them, set up certain mnemonic landmarks; and then, with these, we connect our subordinate memories, knowing, as we do, what their causal relation was, and what order they *must* have had." In this connection the influence of conscious memory in acquiring that insight is of course not to be overlooked. But when it is once acquired it has a higher function than conscious memory can exercise. In this reconstruction of the past by insight, and not by conscious recall, the process *may be* that of conscious inference, but as a rule it is not. Insight like perception is the result of a long training of the individual and of the race, in which nearly all of the steps that it was necessary to take to attain it have dropped out. In it the voice of our past speaks in an effective but unobtrusive tone. We can recall few of the events of our childhood, and of the things that occurred in that long period of learning that has made the adult mind. But the past that is forgotten is not necessarily lost. In some form, by some method, we continue to profit by that experience, and it is more important to have had a good past than to be able to recall it.

The matter of insight into the laws of nature and the construction of the past and the future through it rather than directly through conscious memory is a process of slow acquisition that belongs to the race much more than it does to the

individual. And in this connection it is interesting to raise the question as to the probable place of conscious memory among mental functions in the future of the race. In regard to this topic I can do no better than to quote another passage from Stratton. "With us at present," he says, "memory is the necessary means of rising superior to memory. Our insight is not as yet sufficient to enable us to detect in our immediate and present perceptions a wide range of unperceived facts. So that we must depend upon memory to furnish the large store of experience with which reason works. It is consequently through our power of recollection that we attain that preliminary familiarity with nature and its laws by which we are able later to turn upon memory, correct it, and even shake ourselves free from its dominion. The course of development, therefore, it seems probable, is from an initial state, in animals and children, which is without consciousness of the past, through a period of memory and recollection, and then onward towards a condition of even more perfect consciousness of the past than memory gives; but by insight and not by mechanical retention. Memory thus stands between these extremes as a happy transition expedient, an easy makeshift, mercifully given us during the days of our ignorance, so that we may have the world before us without the need of understanding it. Some such thought seems intended by Beatrice when she says to Dante that the angels have no need of memory, because there is no interruption of their vision; they see all things constantly reflected in the divine countenance."